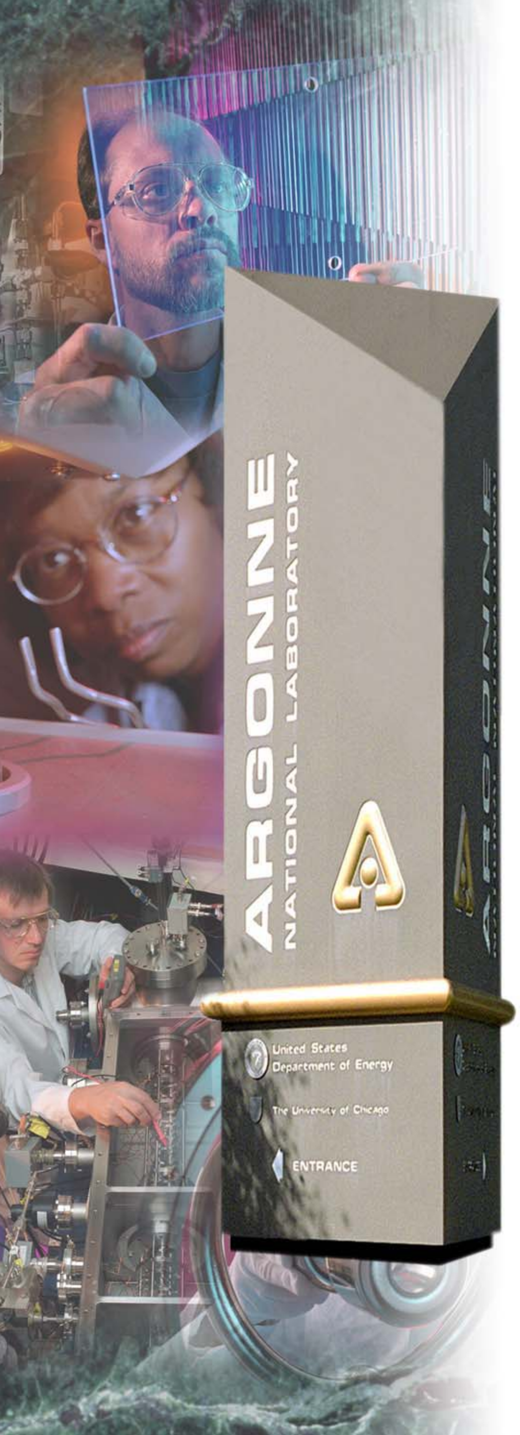

Overview of the RIA Baseline Concept as Reviewed in January, 2001

Part 2 of 1.0.4: Production Targets and Beyond

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August 26, 2003

Argonne National Laboratory

Office of Science
U.S. Department of Energy

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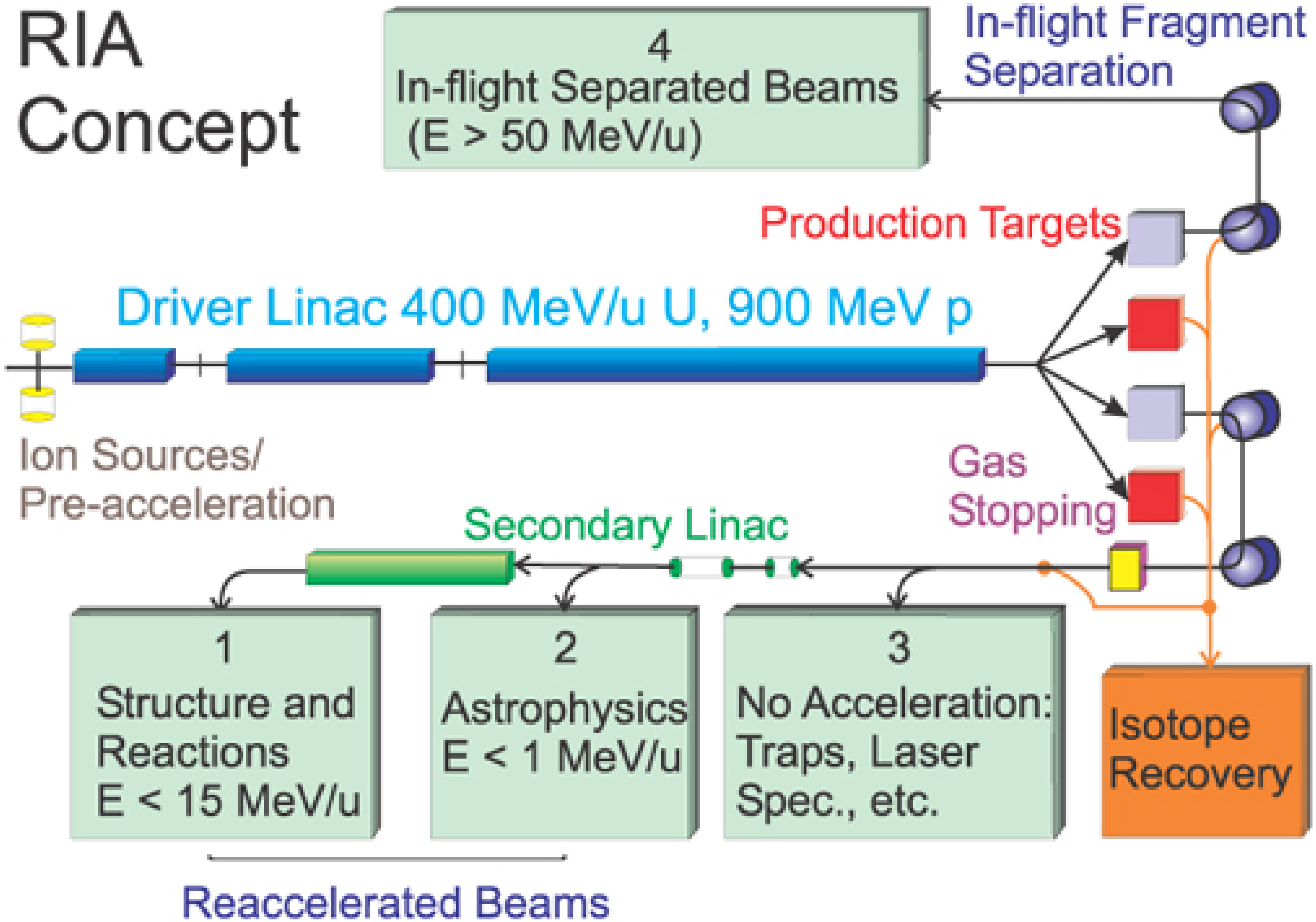
Schematic of the RIA Facility



Important Technical Features of RIA

- High power CW SC Linac Driver (1.4 GV, 400 kW)
  - Advanced ECR Ion Source
  - Accelerate 2 charge states of U from ECR
  - All beams: protons-uranium
  - Superconducting over extended velocity range: 0.2 – 900 MeV/u
  - Multiple-charge-state acceleration after strippers
  - Adapted design to use both SNS cryomodules
  - RF switching to multiple targets

Part 1

~50% of cost

- Large acceptance fragment separators
  1) “Range Bunching” + Fast gas catcher for ISOL
  2) High resolution and high purity for in-flight
- High power density ISOL and fragmentation targets
  - Liquid lithium as target for fragmentation and cooling for n-generator
- Efficient post-acceleration from 1+ ion sources
- Next-generation instrumentation for research with rare isotopes

Part 2

~50% of cost

Much R&D and concept development was already done prior to the 2001 baseline review.

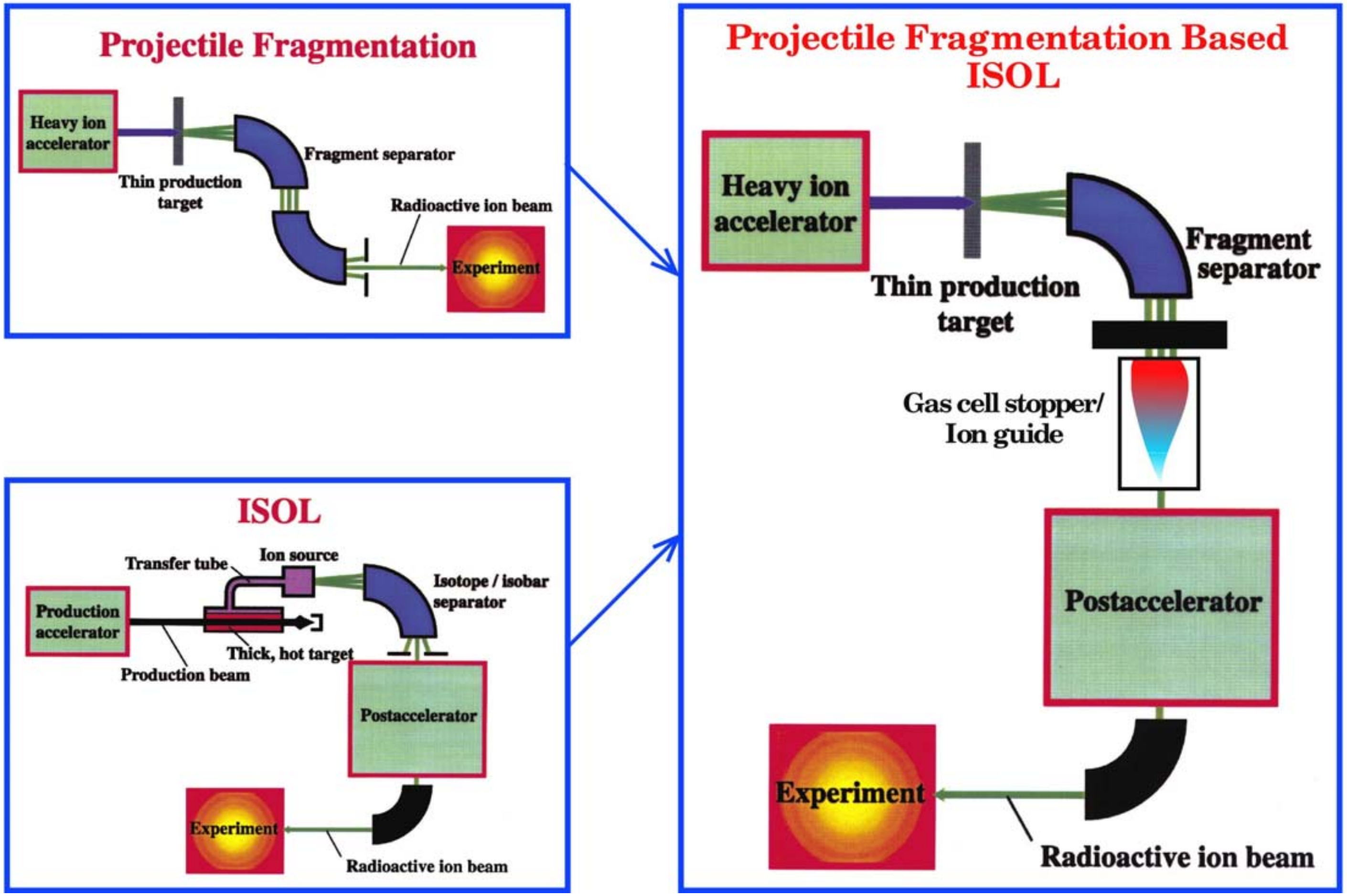
Partial Beam List for Driver Linac

A	I source	Qinj	Qstrip	Qout	I out	Energy out	Beam Power
	pμA				pμA	MeV/u	kW
1	556	1	-	1	445	899	400
3	232	2	-	2	186	717	400
2	416	1	-	1	333	600	400
18	54	6	8	8	40.3	551	400
40	29	8	18	18	18.0	554	400
86	15	14	33-34	36	8.8	515	390
136	12	18	46-48	53-54	6.2	476	400
238	3	28-29	69-73	87-90	1.6	403	152

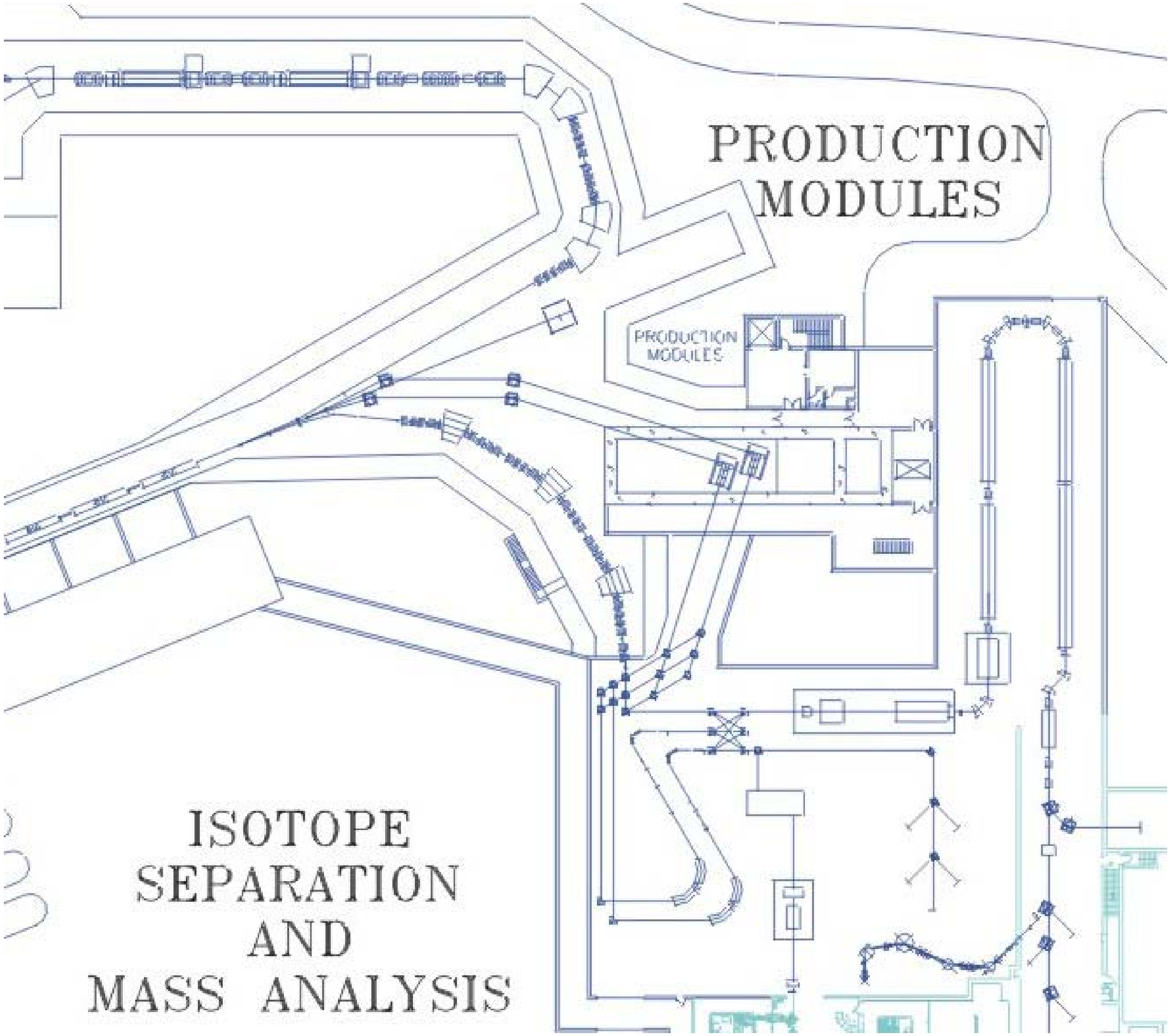
RF power limits beam to 400 kW; the heaviest beams are limited by ion source output at the required charge state

Rare Isotope Production Schemes

- Fast Extraction Times (~msec)
- Chemical independence
- Isobar separation

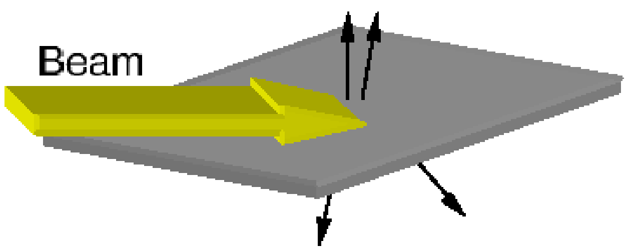


Target Areas and Beam Sharing

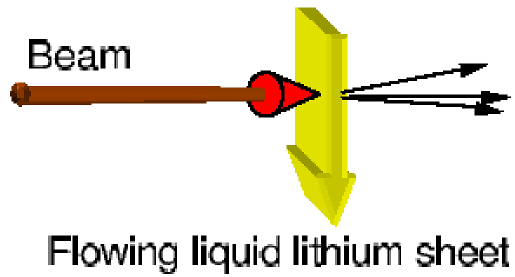


A Variety of Targets and Production Mechanisms

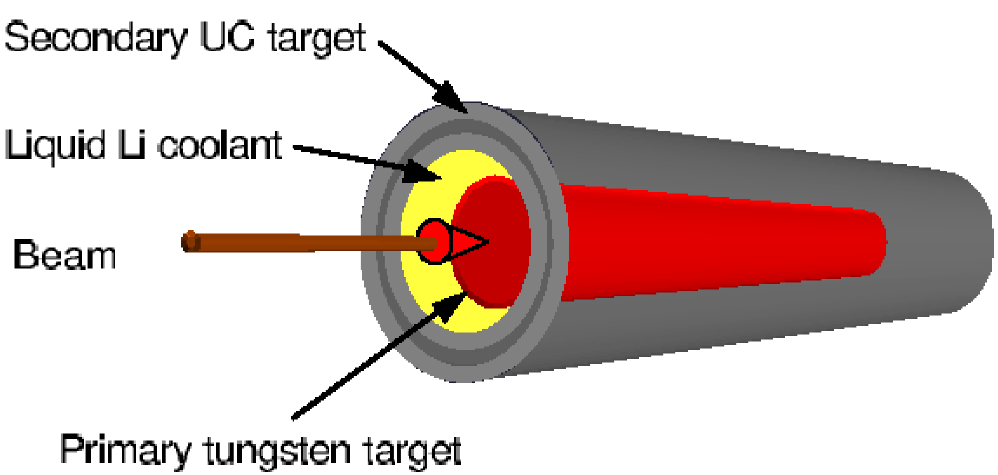
(a) Tilted spallation target



(b) Liquid lithium target

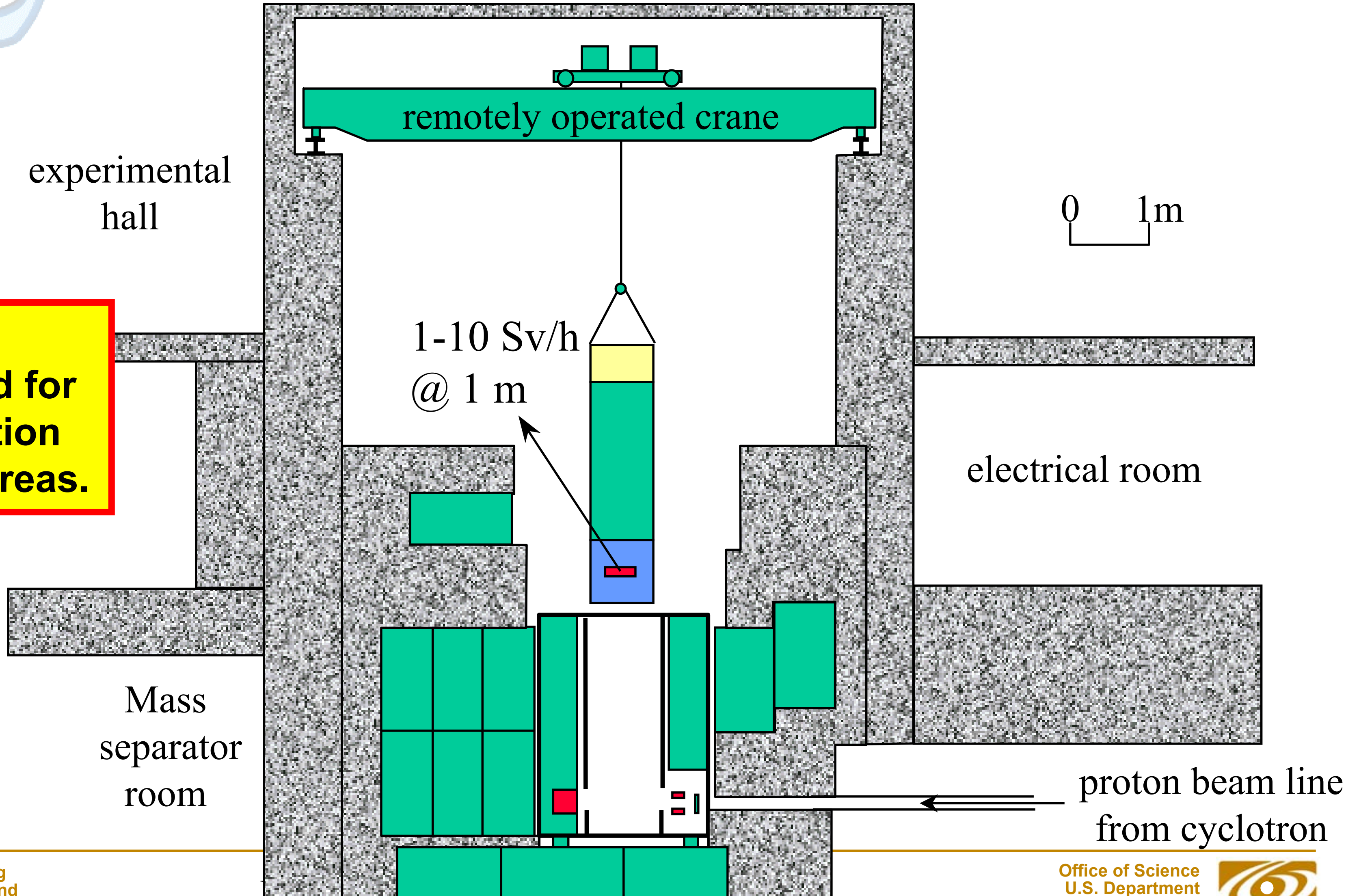


(c) Two-step neutron-induced fission target



R&D required for several types of high power targets.

ISAC target servicing:

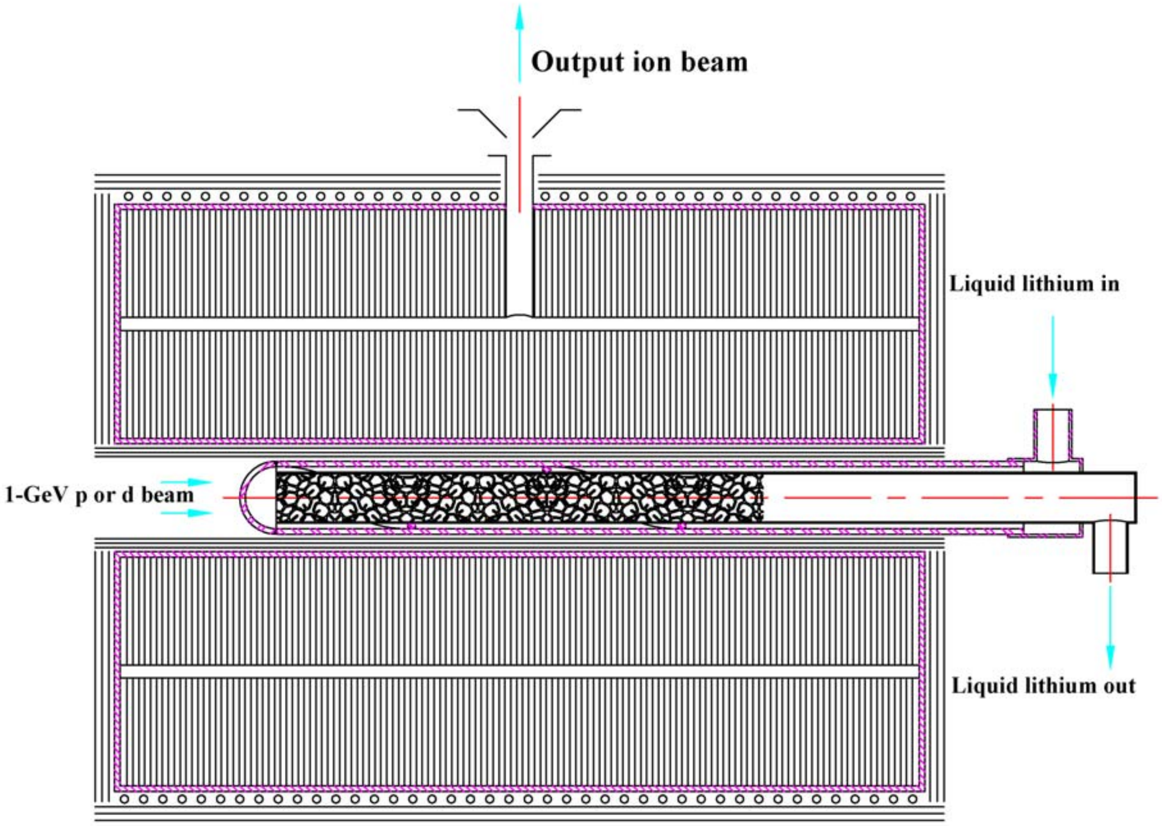


R& D required for production target areas.

Radiological Issues

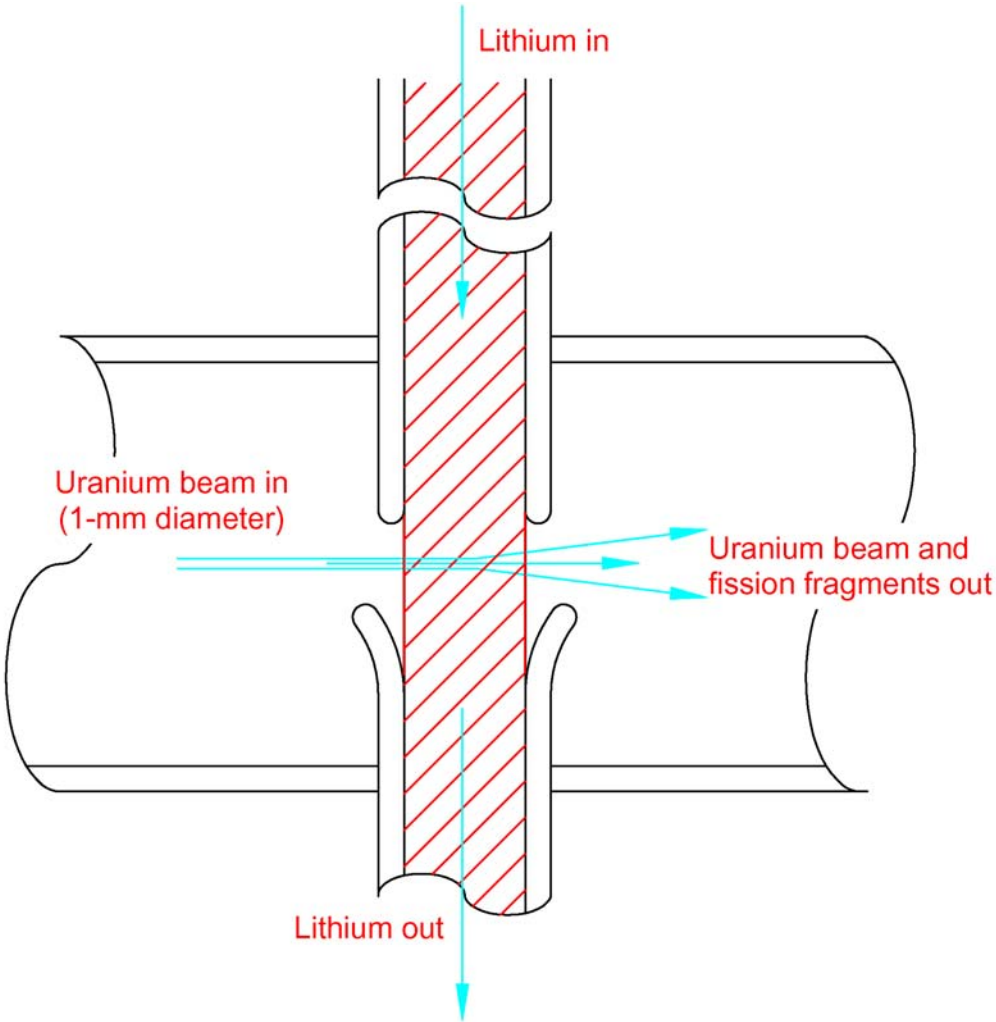
- **Isotope inventory calculations indicate RIA will be a non-reactor nuclear facility**
- **Inventories are predicted to be at the high Category 3 or low Category 2 levels**
- **The production areas can be segregated from the accelerator and experimental facilities**

Two-step, n-generator target concept



2-step, neutron-generator concept target is proposed to decouple beam heating of primary target from secondary UC fission target

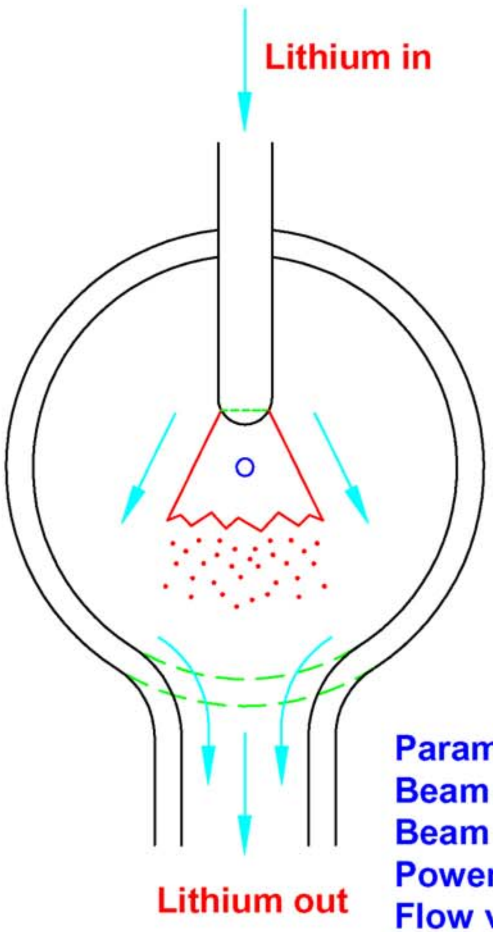
Concept for a windowless liquid lithium target for fragmentation

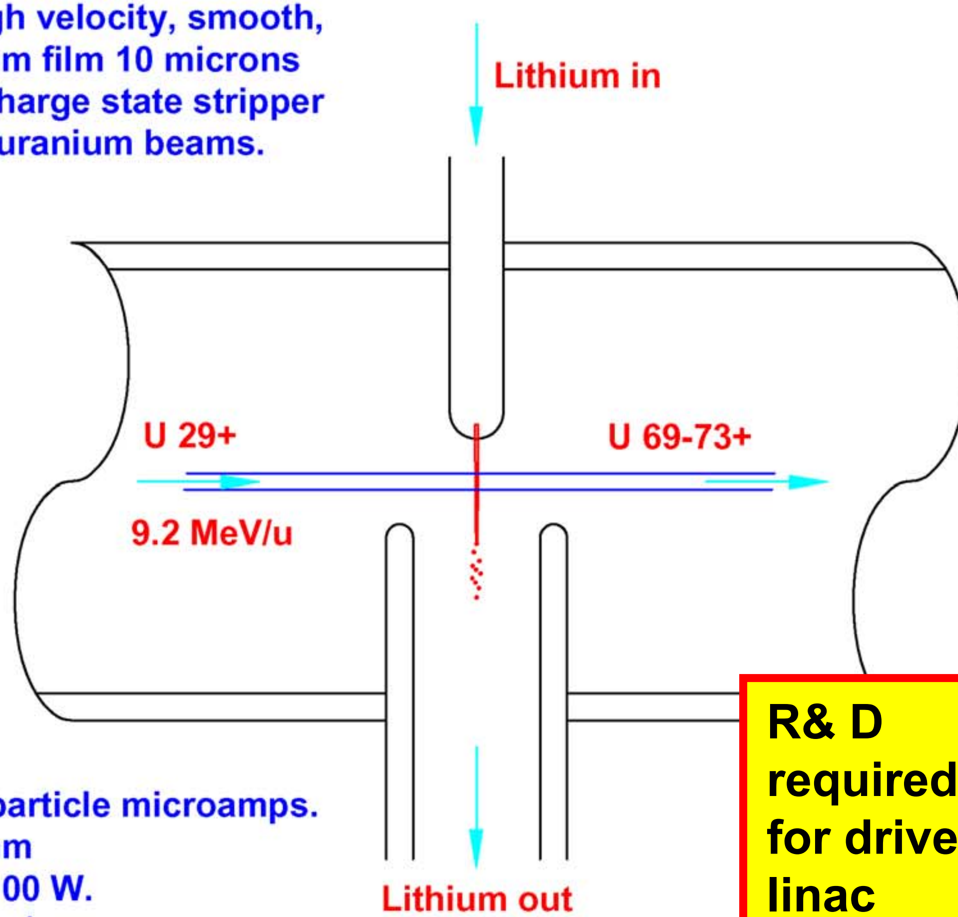


Schematic layout of the concept of a windowless liquid lithium target for in-flight fission or fragmentation of heavy ions up to uranium, designed to work with beam power as high as 100 kW, or 1 MW/cm^3.

Concept for Thin Liquid Lithium Stripper Film

Problem:
Develop high velocity, smooth, stable lithium film 10 microns thick as a charge state stripper for intense uranium beams.





Parameters:
Beam current: 1.5 particle microamps.
Beam diameter 1 mm
Power deposited: 100 W.
Flow velocity: ~30 m/s.
Peak temperature rise: ~200 C.

R& D required for driver linac strippers.

RIA will use 2 types of Fragment Separator

Broad range, energy bunching

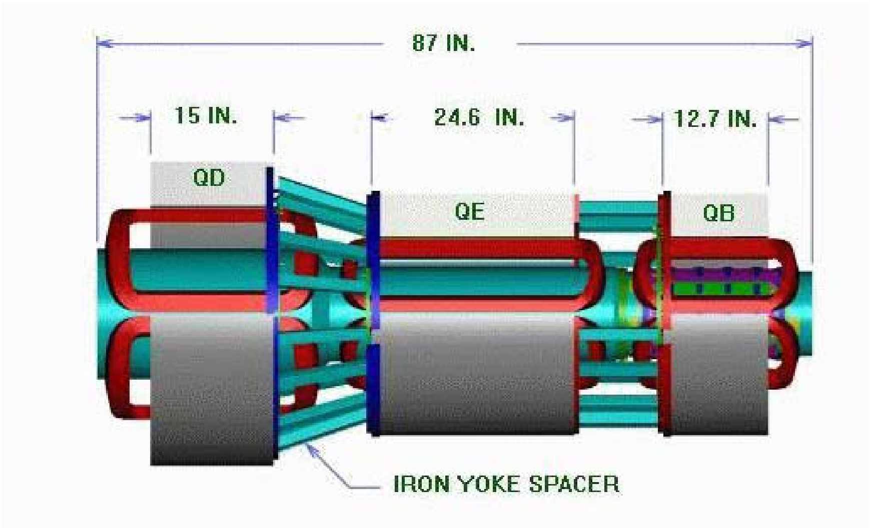
- 18% momentum range
- 10 msr solid angle
- 0.1 % momentum resolution
- Energy spread compensation stage to minimize range straggling in helium gas

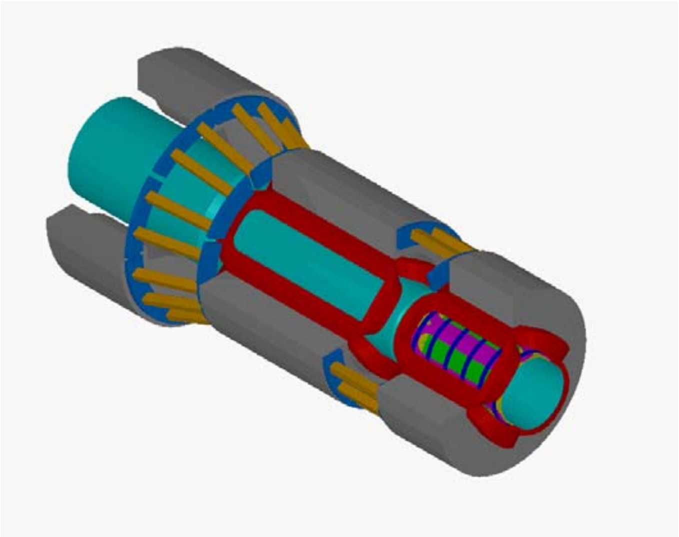
High resolution/high purity

- 6% momentum range
- 10 msr solid angle
- 0.03 % momentum resolution
- Wien filter stage for isobaric purification

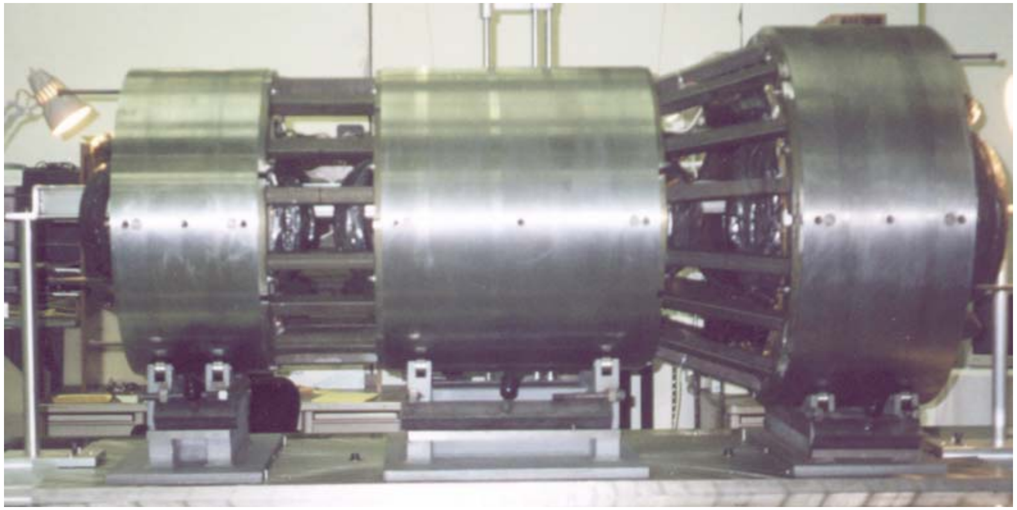
R& D required for several aspects of the fragment separators.

Superconducting QuadrupoleTriplet



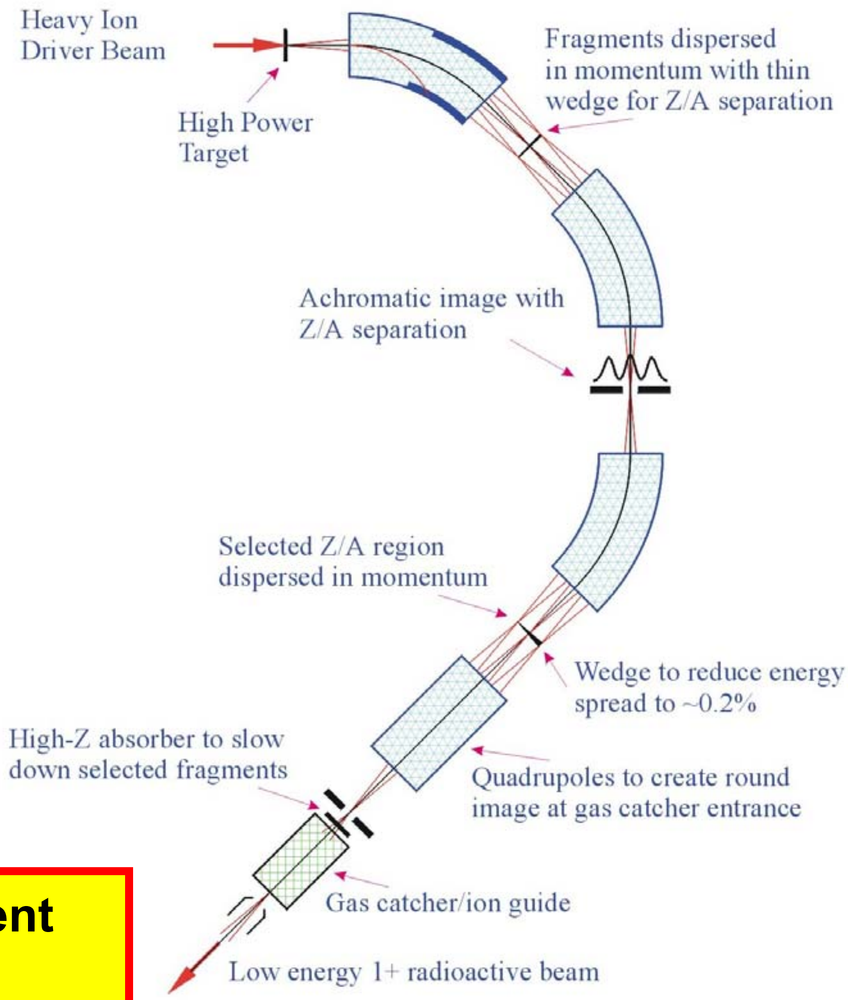


Large aperture magnets as used in the NSCL A1900 are required for large acceptance fragment separators.



Schematic layout of fragment separator and gas catcher system

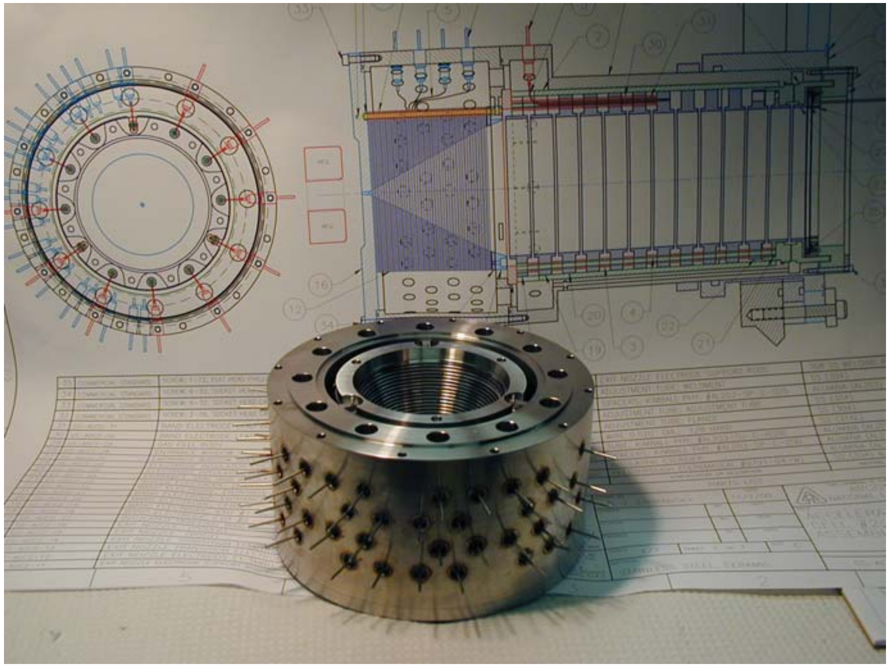
- Production by fragmentation or in-flight fission on high power target
- First section of fragment separator selects reaction products of interest
- Second section reduces the momentum spread of reaction products
- Further deceleration in degrader followed by focusing into high purity gas cell system
- Extraction as thermal 1+ ion beam

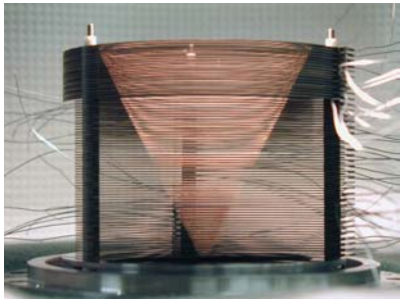


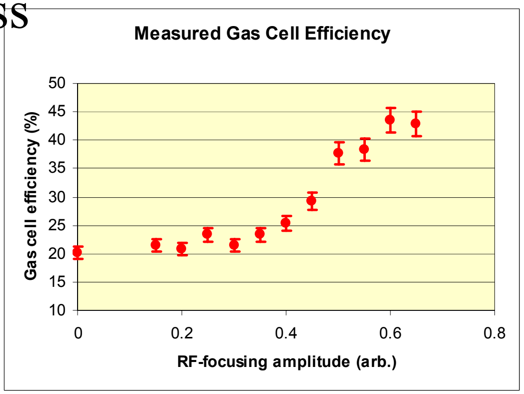
R& D required for further development of gas catcher system.

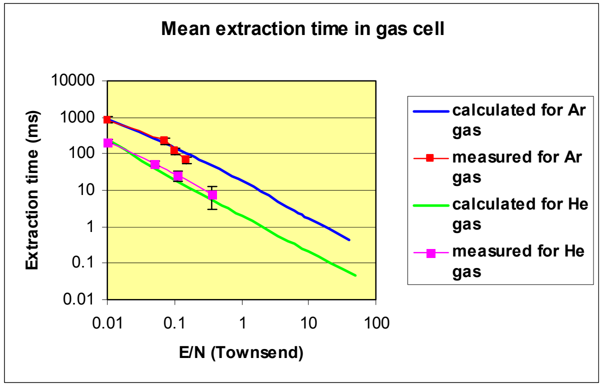
Gas Cell Performance at the CPT

- 20 cm long gas cell with first generation RF cone
- ε ~ 45%
- mean delay time below 10 ms
- tested off-line with fission products and on-line with fusion–evaporation reactions
- routinely used for physics with CPT at Argonne for mass measurements on short-lived isotopes



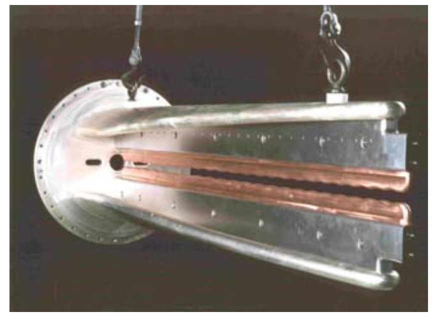


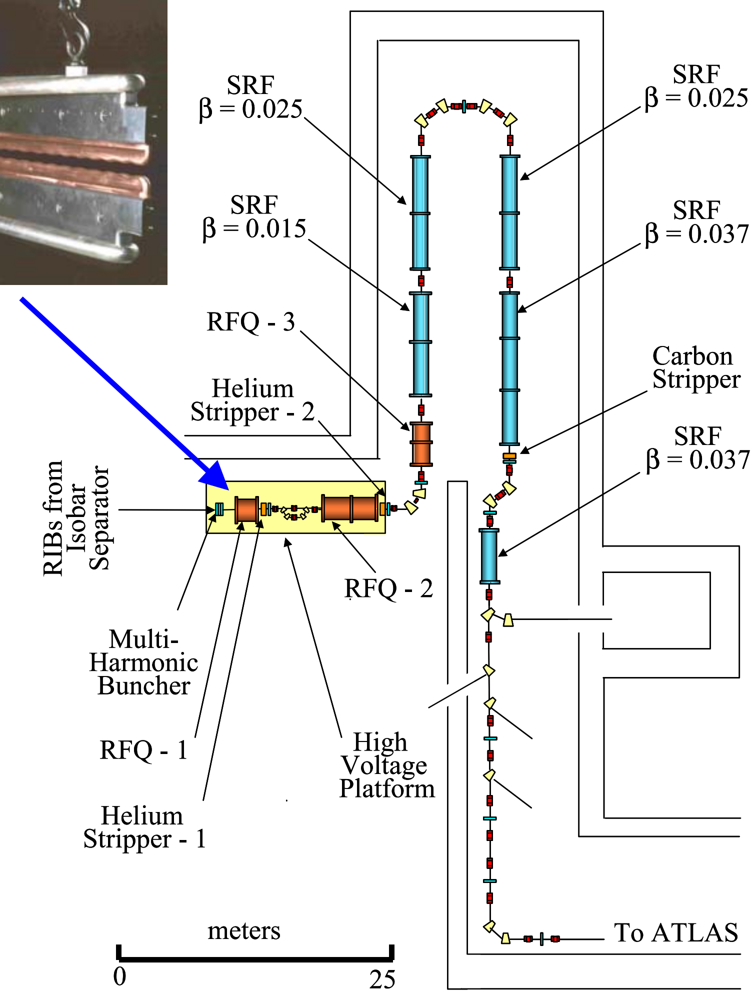




RIA post-accelerator: Injector for 1+ mass 240

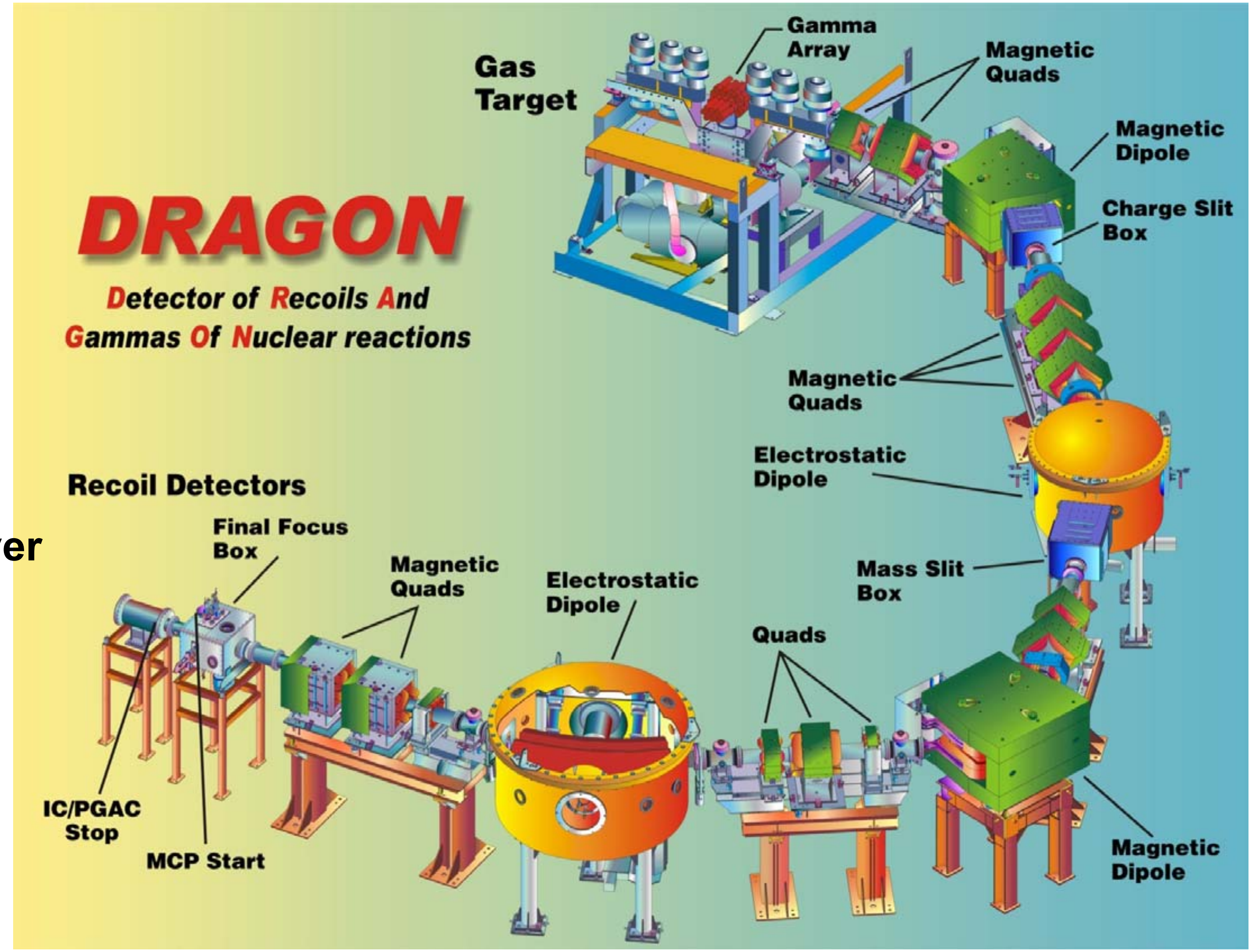
- **Can accelerate, starting from singly charged, ions with mass up to 240 amu from ion source energy to energies above Coulomb barrier**
- **High-acceptance CW operation**
- **Uses novel low-frequency CW split-coax RFQ and two H-RFQ structures to inject into low-β superconducting cavities**
- **Low-energy non-equilibrium charge state stripping in helium has twice the efficiency of standard techniques, and it preserves beam quality.**
- **Most efficient post-acceleration scheme available**





Instrumentation for research with rare isotopes

Next-generation recoil separator developed for ISAC in Vancouver



Experimental Facilities

- A variety of next-generation instruments are required for research in the four energy regimes
- It is too early to specify these instruments in detail
- A $100M “trust fund” will be set aside for the instruments
- Two RIA research instrumentation workshop have already been held: see presentation by Thoennessen (paper 1.2.1)

Summary (from 2001 talk)

- **RIA brings together a powerful, unique combination of advanced technologies to make possible a premier facility for nuclear science.**
- **Use of proven technologies together with simulations, engineering studies, and prototyping indicate that there are no show-stoppers and we are ready to build RIA.**
- **Ongoing development and prototyping of RIA components as currently coordinated by a national committee must continue.**